



WMGroup

Building Resiliency with Societal Benefits through Microgrids

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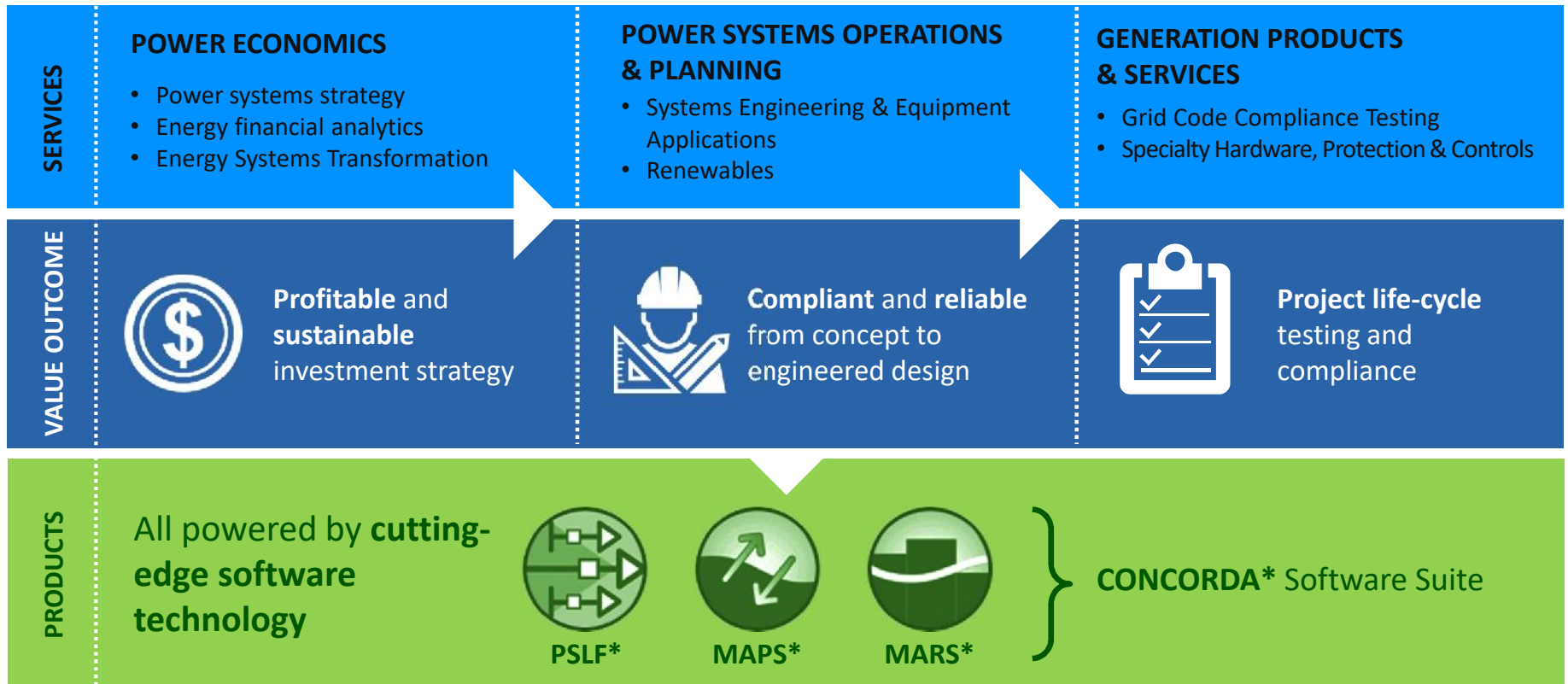
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Agenda

- About Us
- Background on Microgrids
- NY Prize Competition
- Project Examples
- Observations and Lessons Learned

GE Energy Consulting - Systems engineers **solving challenges** that deliver customer value



TAILORED Power Systems and Energy Course: Longest running energy executive development program

Serving global customers with local expertise

WORLD - RENOWNED

More than 100 recognized
electric power systems industry
experts

INNOVATING & PIONEERING

More than 100 patents
awarded in the last 30 years

INDUSTRY LEADERSHIP

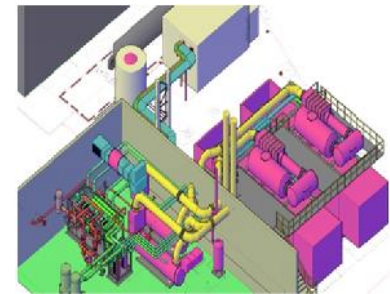
3 IEEE Life Fellows, and one
member of the U.S. National
Academy of Engineering



Our Company

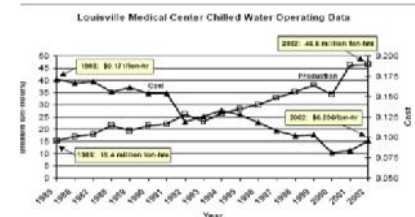


- ▶ Engineering Consulting Company primarily focused on Central Utility Plants, Cogeneration and commissioning.
- ▶ Over a decade, WM Group has saved substantial energy and reduced carbon footprint for many customers.
- ▶ Solutions range from simple operating changes to optimization of plants to master planning for campuses.
- ▶ WM Group has gained the reputation of being the best in optimizing systems.



Expertise

- ▶ Review of Existing Systems
- ▶ Master Planning
- ▶ Detailed Design
- ▶ Feasibility Studies
- ▶ System Optimization
- ▶ Equipment Procurement
- ▶ Field Services
- ▶ Commissioning & Startup
- ▶ Operator Training
- ▶ Offline Plant Operation Advisory
- ▶ Peer Review
- ▶ Expert Witness



Microgrids Background

What are Microgrids?

MICROGRIDS

=

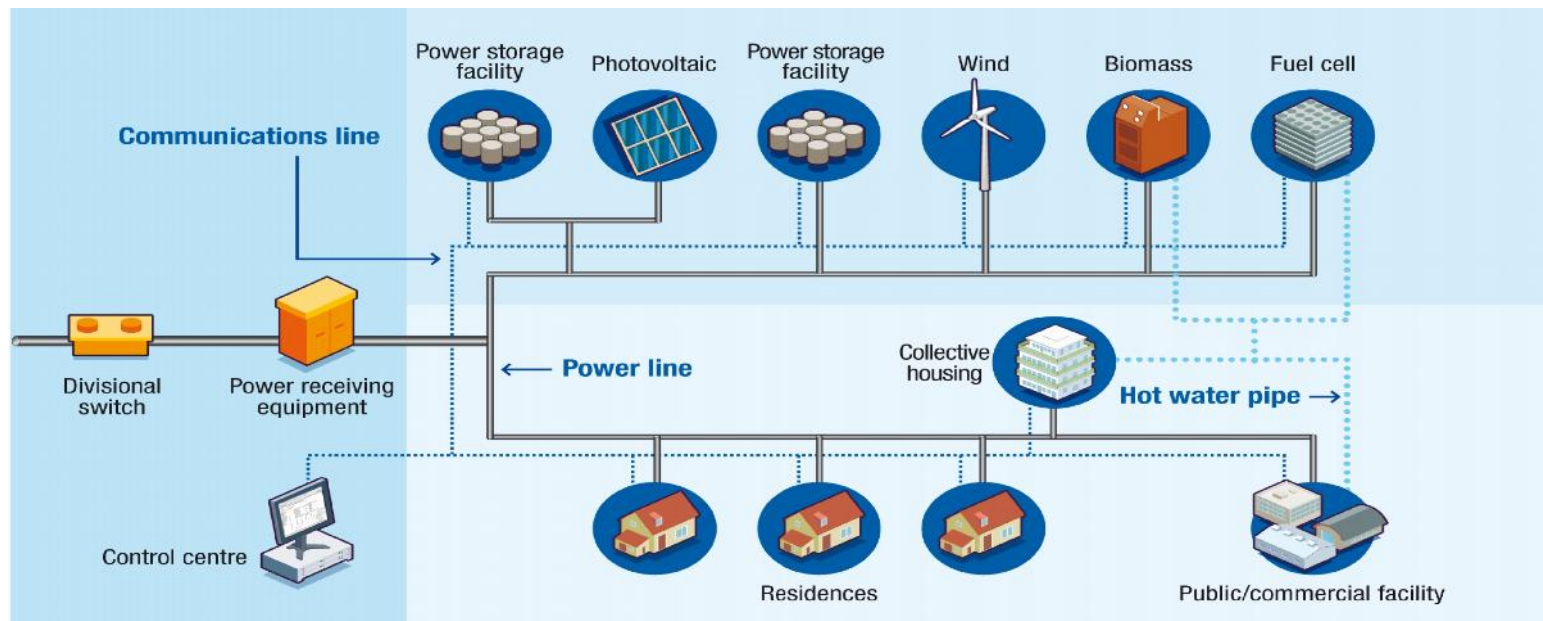
Integrated Energy System and
Control

+

Distributed Energy Sources
(Generation, Storage)

+

Loads
(Demand Response)

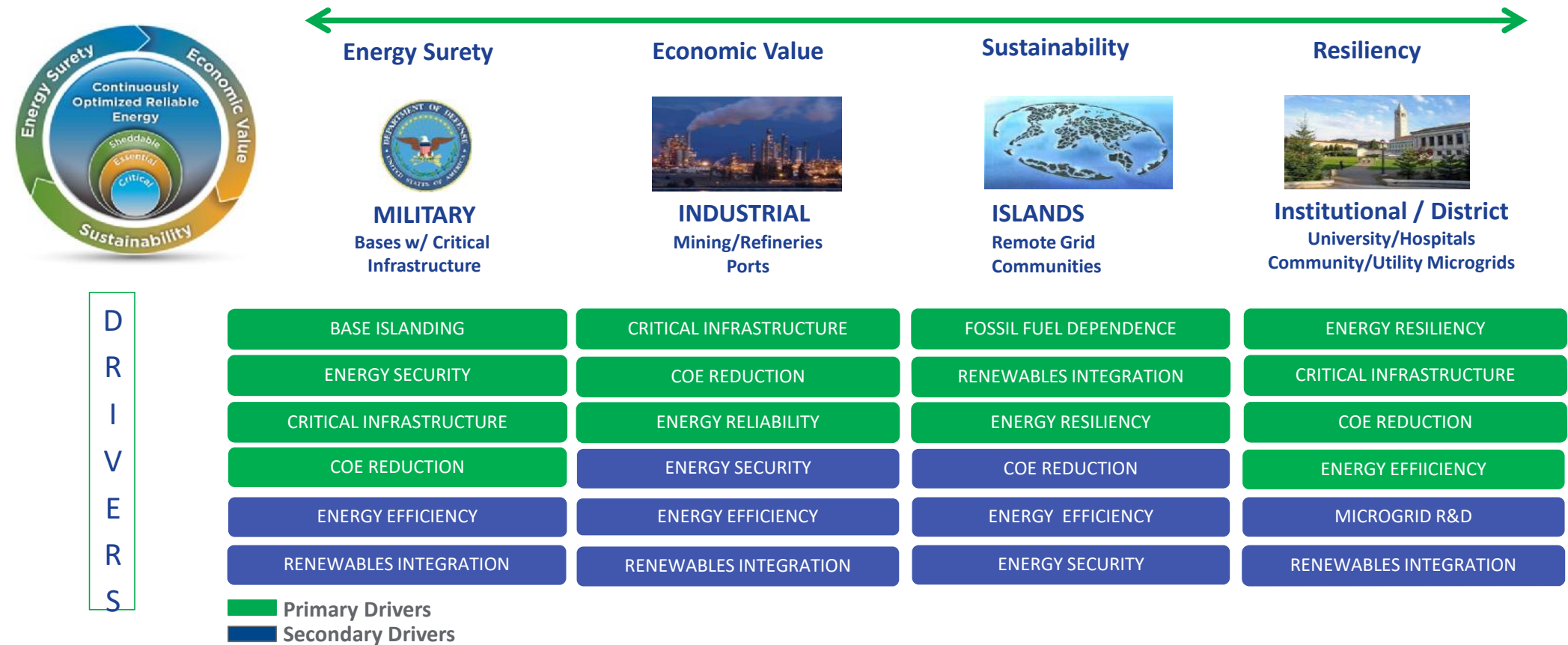


Microgrids

An integrated energy system that has distributed energy resources and interconnected loads, operated in parallel with the grid or in an intentional island mode.



Market Segments and Drivers



Convergence of environment, energy cost/efficiency, security, and system resiliency and reliability prove to be the key drivers for Microgrids . . .

Principal Elements of Microgrids and Minigrids



Supply Side/DER

Distributed Generation

- Fuel Cells
- Gas Turbines
- Micro-turbines
- RICE
- CHP/CCHP
- Solar PV

Energy Storage

- Battery Storage
- Thermal Storage
 - Heat
 - Cool



Power Delivery

Distribution infrastructure

- Lines/cables
- Transformers
- Switchgear

Protection and Relaying

- Breakers/relays
- Fuses
- Reclosers/sectionalizers
- Coordination

Automation/Smart Grid

- Smart devices
- Dynamic reconfiguration



Demand-Side

Load/demand

- Critical loads
- Discretionary loads
- Curtailable loads

Demand Response & Energy Efficiency

- Event-Responding Demand Response
- Price Responding Demand Response (Dynamic Pricing)

Electric Vehicles (EV)



Control and Comms

Microgrid Controller

- Monitoring and Visualization
- DER Dispatch
- Optimized operation
- Command & Control

Communications & IT

DERMS/DMS integration

Cybersecurity



Microcosm of an electric power systems with associated challenges and opportunities

NY Prize Competition



NY State Energy Plan for 2030

Regulation & Policy

- Reforming of Energy Vision (REV)
- Clean Energy Standards

Guiding Principles

- Fostering more DER
- Market Transformation
- Community Engagement
- Economic Efficiency
- Private Sector Investment
- Innovation and Technology
- Customer Value and Choice

Goals

- 40% reduction in Greenhouse gas (GHG) emissions from 1990
- 50% of electricity generation from renewable energy resources
- 23% decrease in building energy consumption
- 600 Trillion BTU increase in statewide energy efficiency

NY Prize Community Grid Competition

Complete

Stage 1: Feasibility Study (2015 -2016)

- Qualitative Characterization of the community grid
- Description of Technical, Commercial and Financial Feasibility
- Conceptual Design of Electrical and Communication Infrastructure
- Preliminary commercial structure
- Preliminary financial model
- Identify regulatory/policy hurdles

\$100K per 83 projects

Near Complete

Stage 2: Detailed Design (2017-2018)

- Detailed Technical/Engineering Design
- Project Valuation and Investment Planning
- Regulatory/Legal, Environmental Assessment
- Development of Formal Commercial Terms/Contractual Relationships
- Final Detailed Project Development and Operational Proposals

\$1M per 11 projects

Stage 3: Project Buildout (2019+)

- Overall cost and benefits of the project
- Portion of project revenue requirements provided by private sector
- Project's contribution to public need
- Technical and operational performance
- Demonstrated reliability of microgrid configuration
- Use of clean and renewable generation resource

Funding levels TBD

NY Prize Microgrid Design Elements

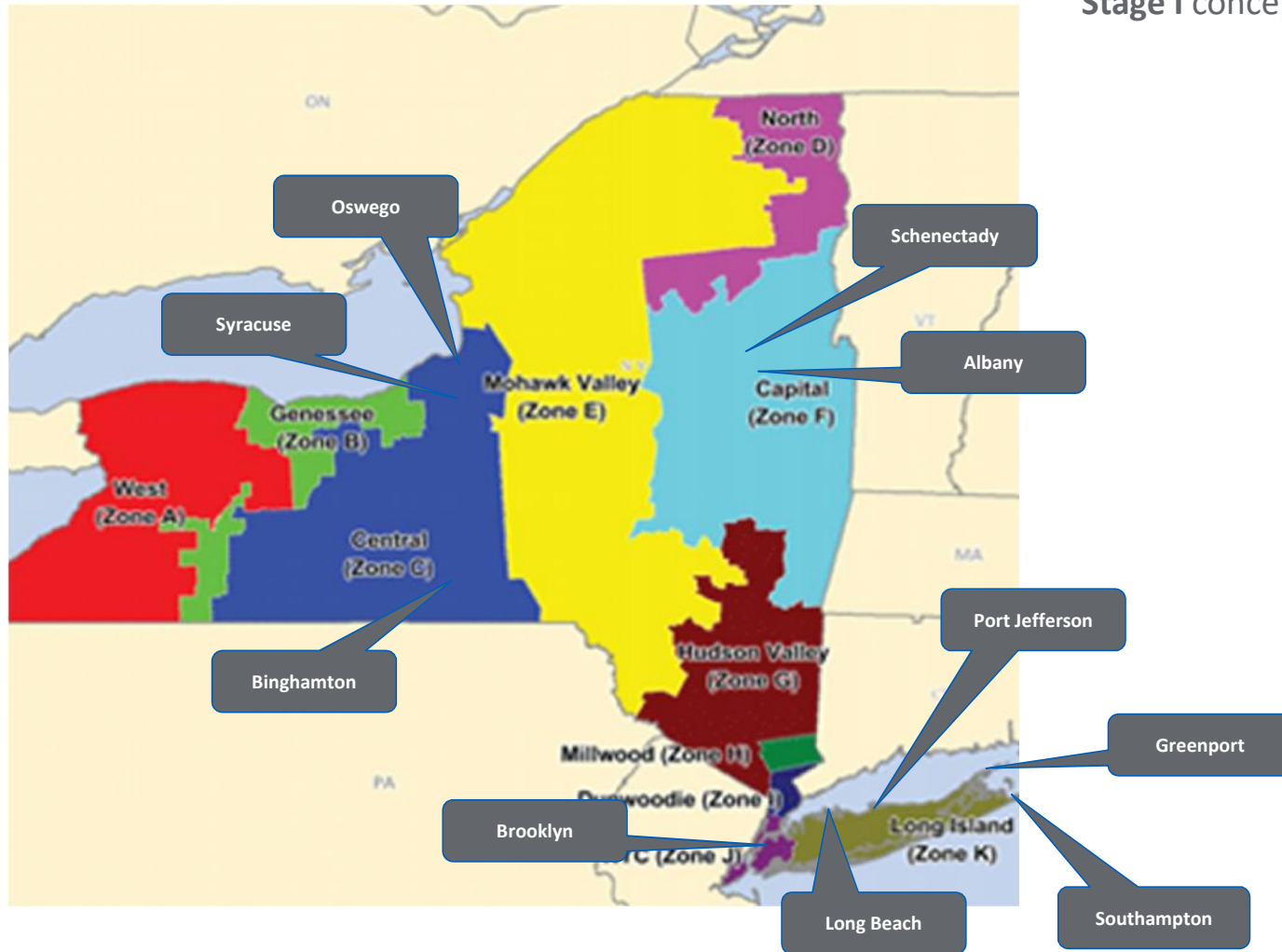


Project Features and Technologies

- Power critical facilities in the community during major events
- Use existing and/or new T&D infrastructure to connect loads to disparate sources
- Incorporate a variety of DER (not just diesel)
- Optimize operation using advanced communication and control technologies
- Significant societal benefit predicated on resiliency and reduced fossil fuel use
- Multiple Points of Interconnection (POIs) to the main grid

Our Team Stage 1 Projects

Worked with **ten** communities and **five** utilities to develop **Stage I** conceptual designs



Our team Stage 2 Projects

Worked with **five** communities and **three** utilities to develop **Stage II** detailed designs



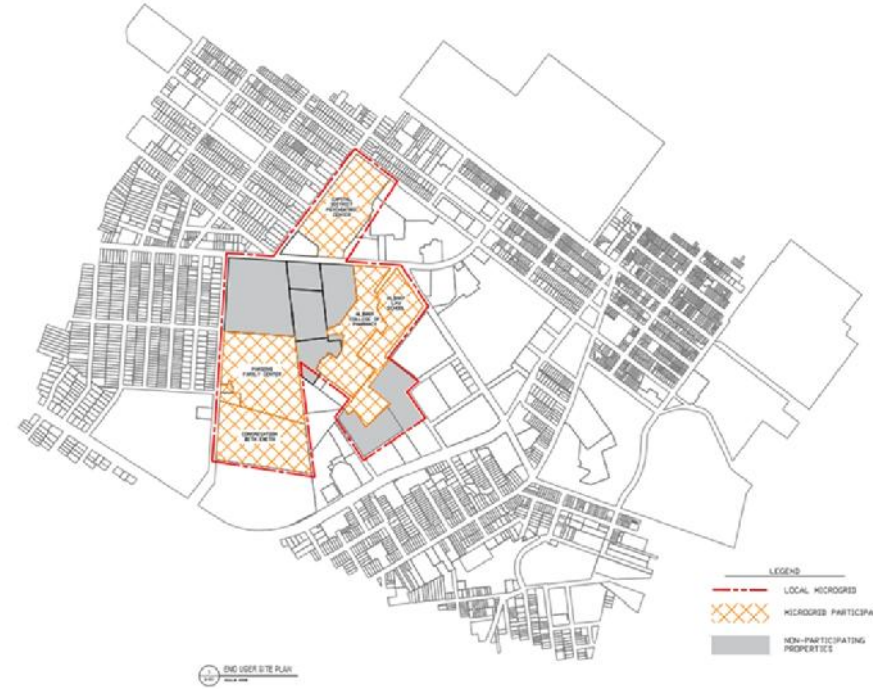
Albany University Heights Project

Project Participants

End-users



Execution Team



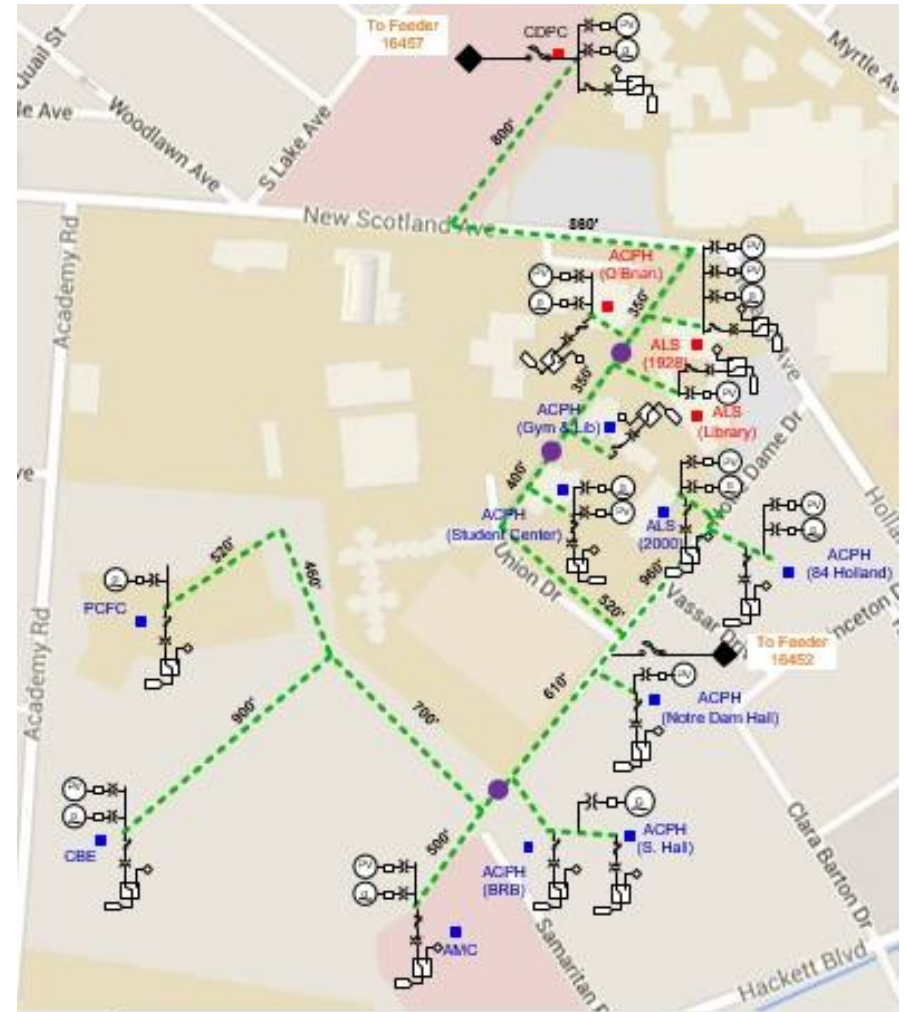
Participant	Type	Peak Load (~kW)
ACPHS	College	1,800
ALS	College	600
AMC SCCC	Hospital	1,100
CDPC	Hospital	1,500
Parsons	Services	600
CBE	Synagogue	100



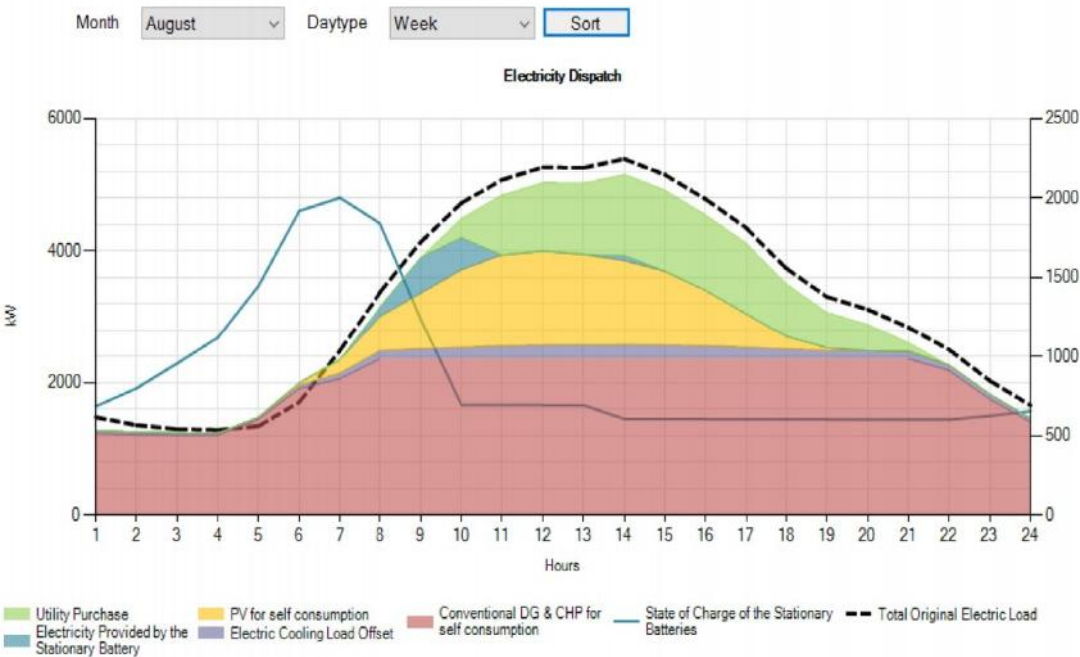
Design and Operating Concept

Campus-style microgrid:

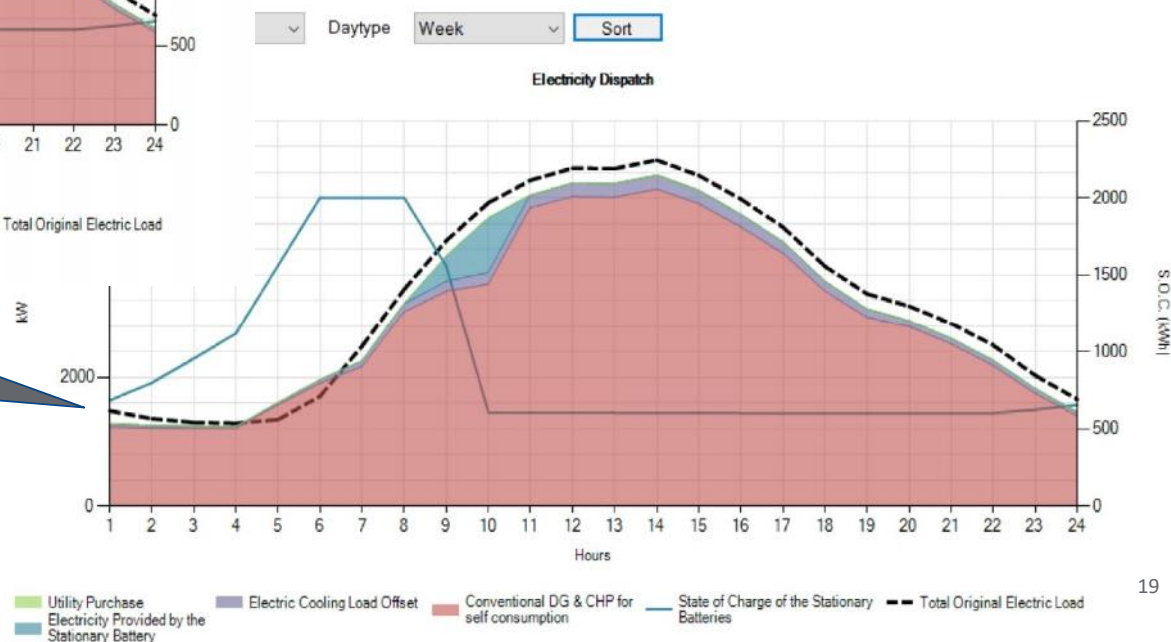
- Normally connected to and supplied from utility grid but can “island” during an emergency
- Dedicated UG distribution network
- Two POIs with National Grid - Trinity 57 and 52 feeders
- DER at several load locations
 - 2,500 kW Solar PV
 - 2,000 kW fuel cells
 - 1 MW/2MWh battery storage
 - 3,000 kW of existing backup generation
- Microgrid controller to optimize operation, dispatch and synchronize generation



Operation and Dispatch for Resiliency



- Microgrid operation for normal (grid-connected) week in August.
- Loads supplied by a combination of grid purchase and onsite generation + storage



- Microgrid operation for emergency (islanded) week in August.
- Loads are completely supplied by onsite generation + storage

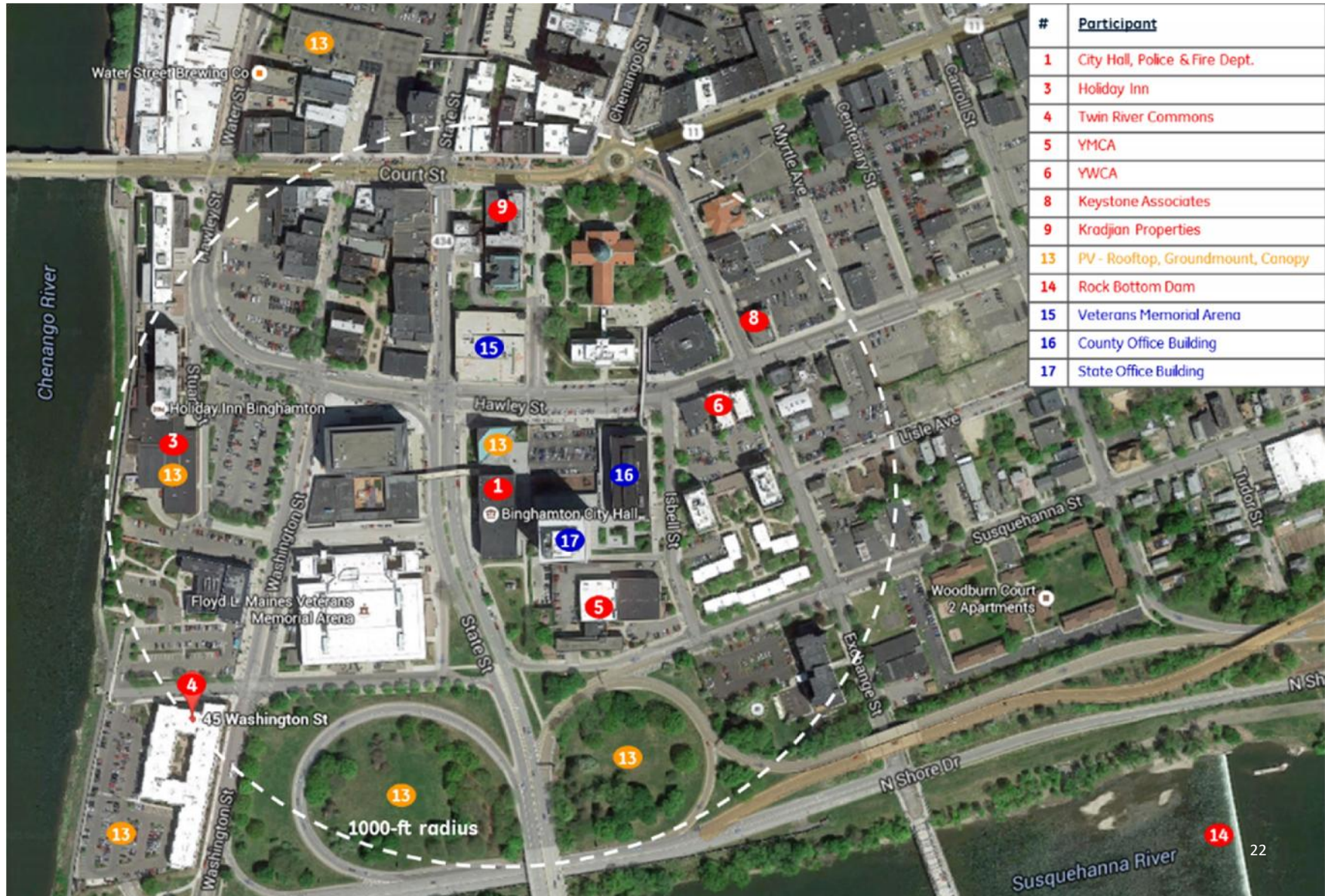


Binghamton Project

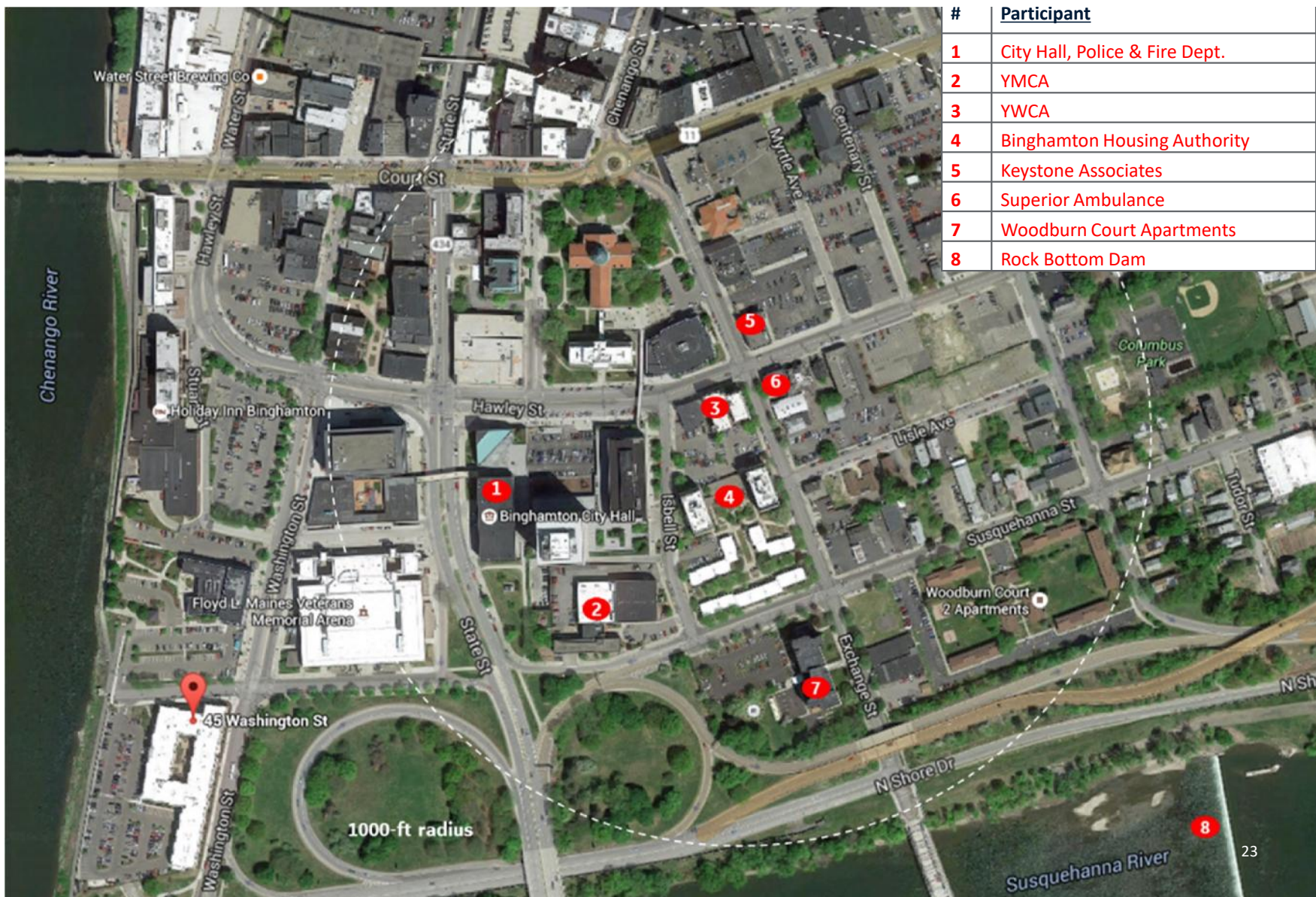


Critical Facilities Downtown Between the Two Rivers

Starting point
for stage 1
design

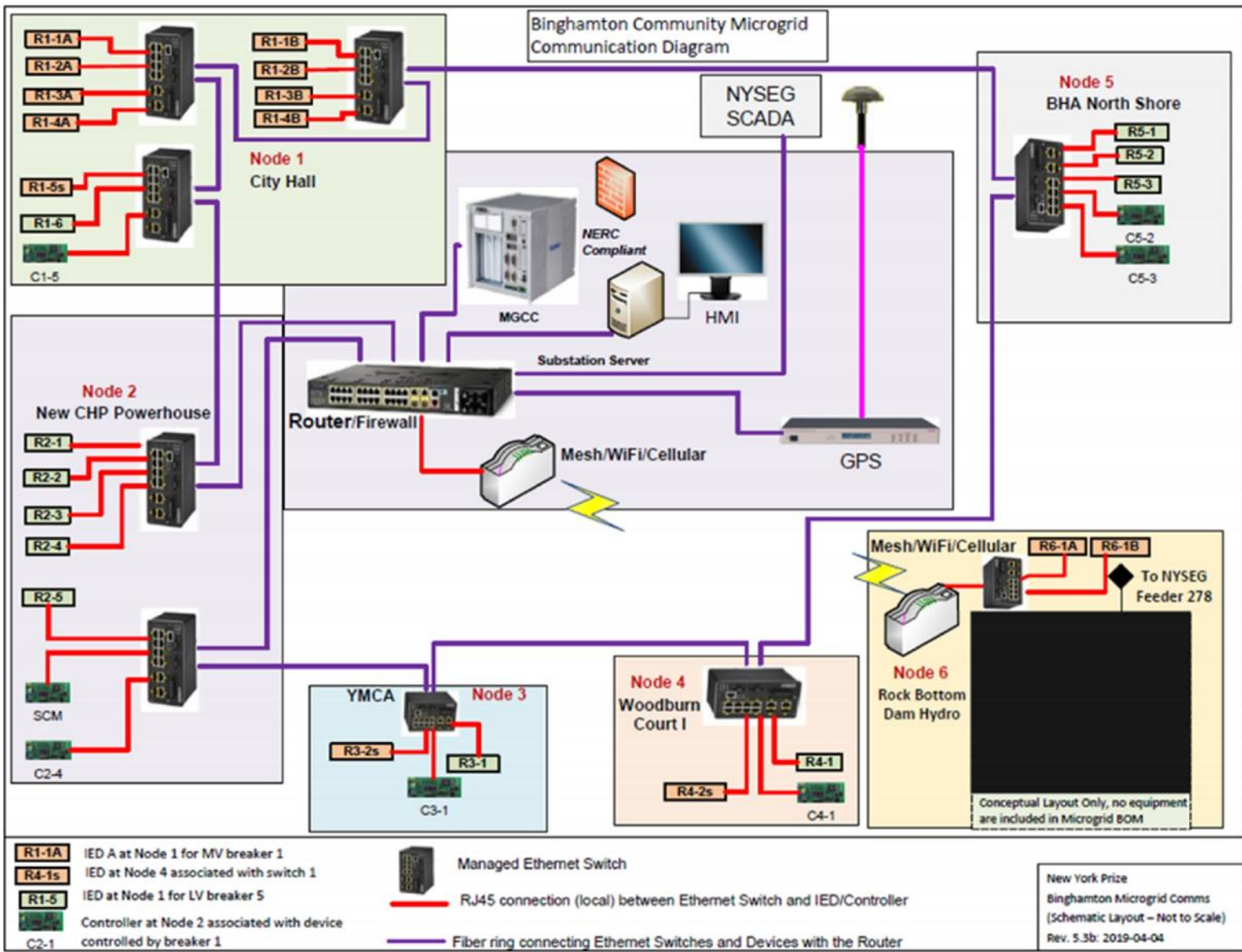


Final Stage 2 Participants

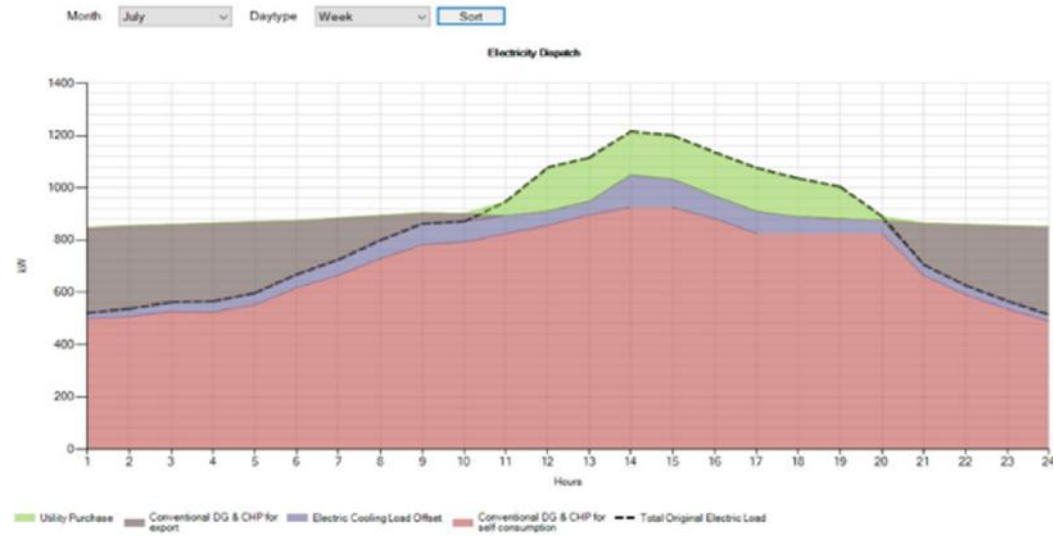


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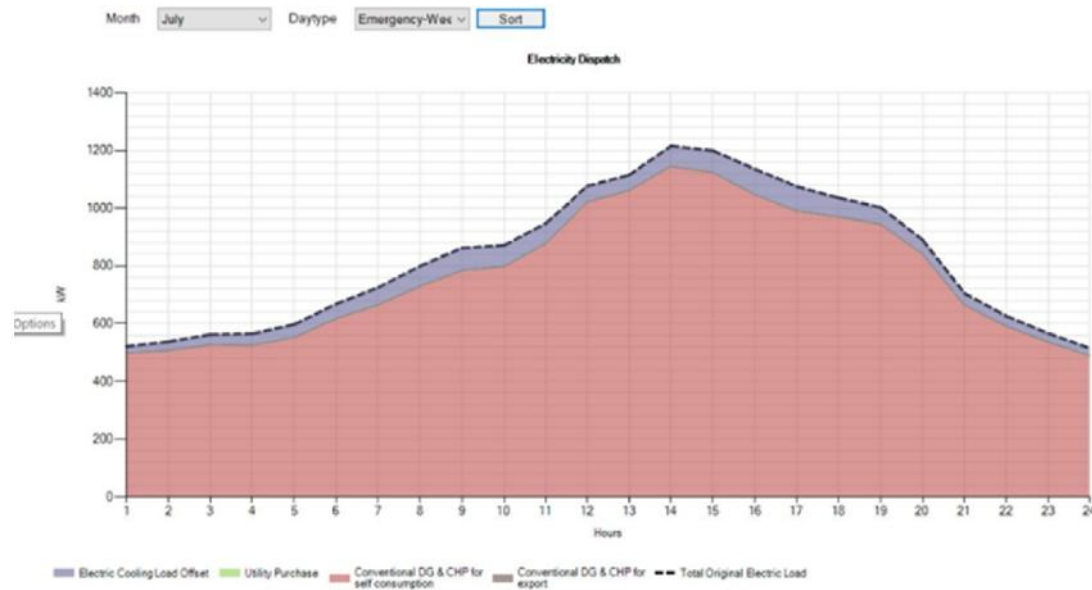
Control and Comms Layout



Microgrid Dispatch for Normal week in July

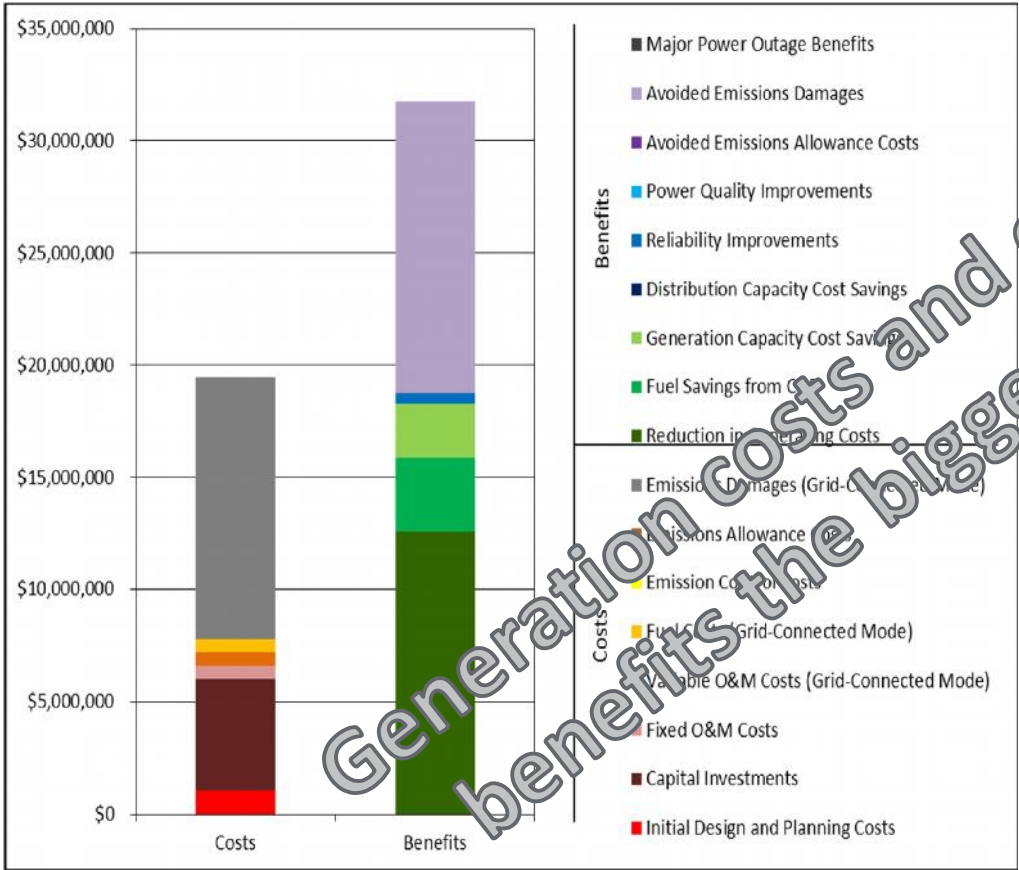


Microgrid Dispatch for Emergency week in July



Summary of Benefit-Cost Analysis (Stage 1)

Binghamton



COST OF BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014\$)
Costs	
Initial Design and Planning	\$1,050,000
Capital Investments	\$4,970,000
Fixed O&M	\$567,000
Variable O&M (Grid-Connected Mode)	\$626,000
Fuel (Grid-Connected Mode)	\$559,000
Emission Control	\$7,930
Emissions Allowances	\$0
Emissions Damages (Grid-Connected Mode)	\$11,700,000
Total Costs	\$19,500,000
Benefits	
Reduction in Generating Costs	\$12,600,000
Fuel Savings from CHP	\$3,310,000
Generation Capacity Cost Savings	\$2,370,000
Distribution Capacity Cost Savings	\$0
Reliability Improvements	\$465,000
Power Quality Improvements	\$0
Avoided Emissions Allowance Costs	\$6,910
Avoided Emissions Damages	\$13,000,000
Major Power Outage Benefits	\$0
Total Benefits	\$31,800,000
Net Benefits	\$12,300,000
Benefit/Cost Ratio	1.6
Internal Rate of Return	28.4%

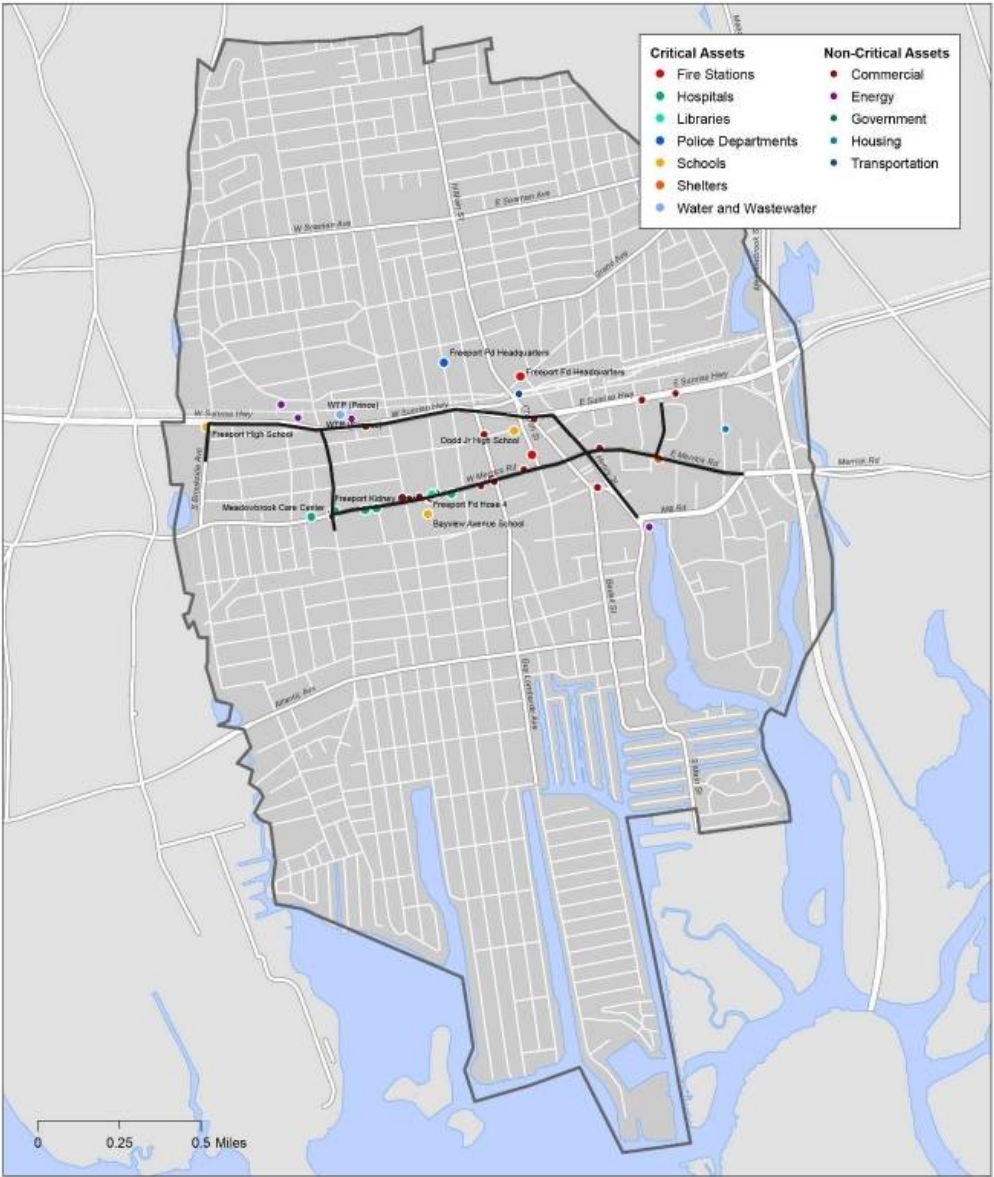


Freeport Project

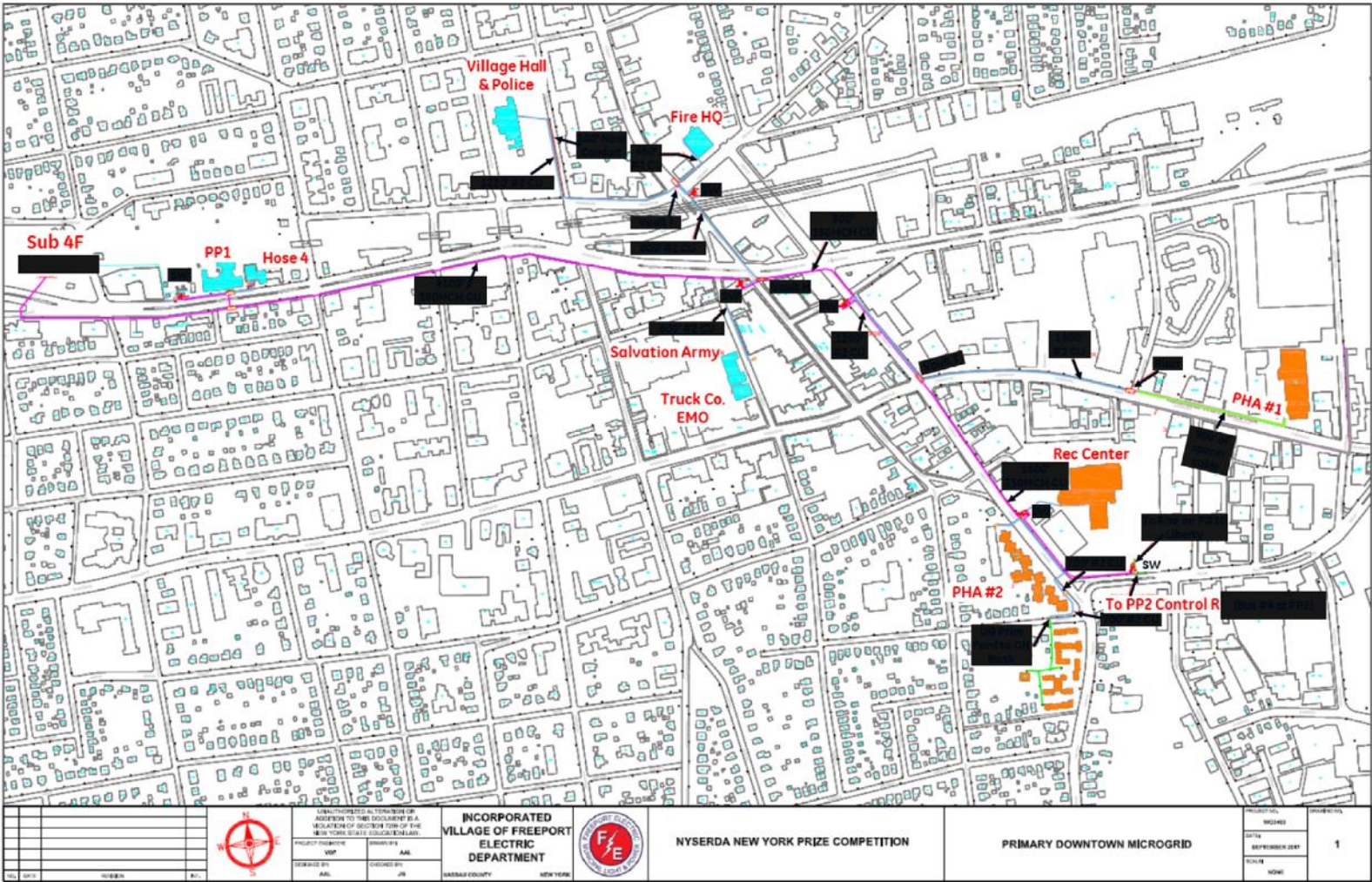
Critical Facilities and DER

	Public Safety Microgrid	~Coincident Peak (kW)
1	Village Hall/Police	250
2	Truck Co/EMO/Salvation Army	510
3	Power Plant 1	120
4	Water supply facility 5,6	30
5	Vault I/Fire HQ	320
6	Hose 4	20
7	Moxey Rigby Housing Complex	160
8	Public Housing 2	50
9	Recreation Center	760
10	Power Plant II (Control Center)	100
	Public Safety Microgrid Total	2,320
	Village of Freeport Total (over 40,000 residents)	58,000

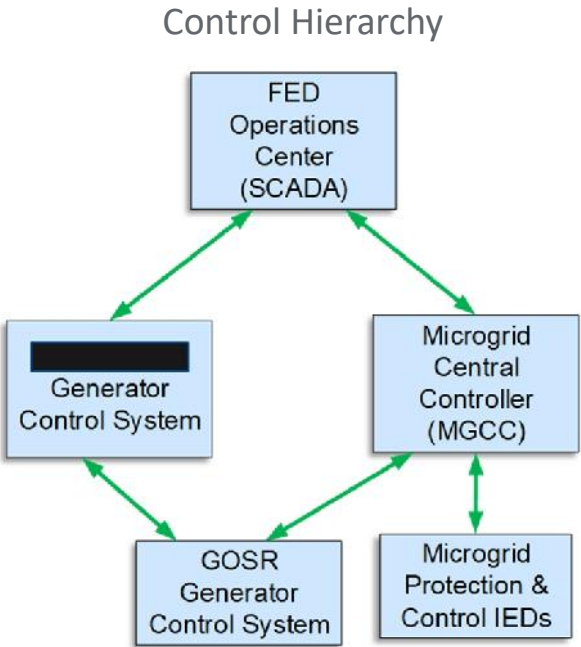
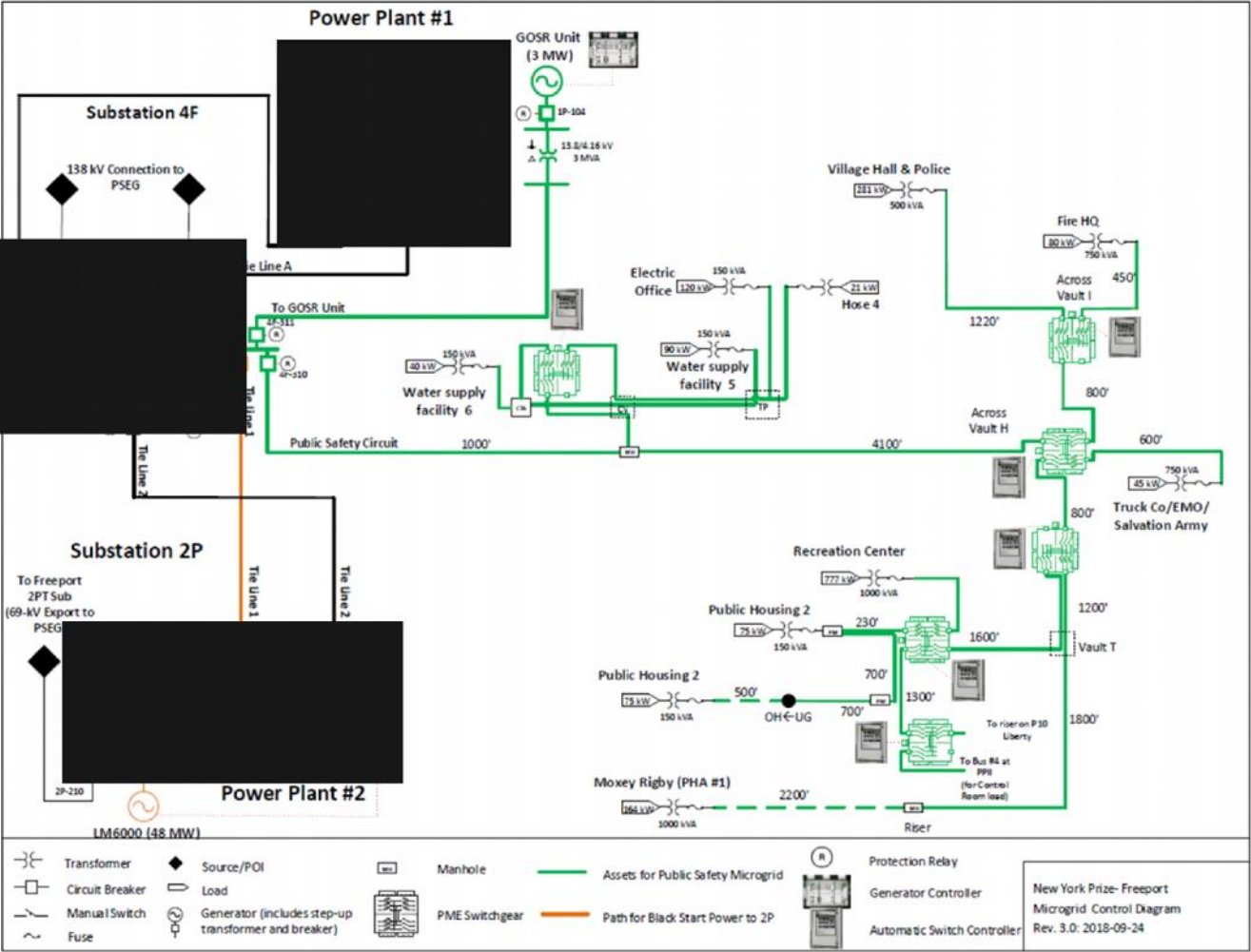
	DER	~Capacity (kW)
1	GOSR Unit – Power Plant I	3,000
2	LM6000 – Power Plant II	48,000+
3+	Older units at PPI and PP2	20,000+
	Total	70,000+



Public Safety Microgrid Layout

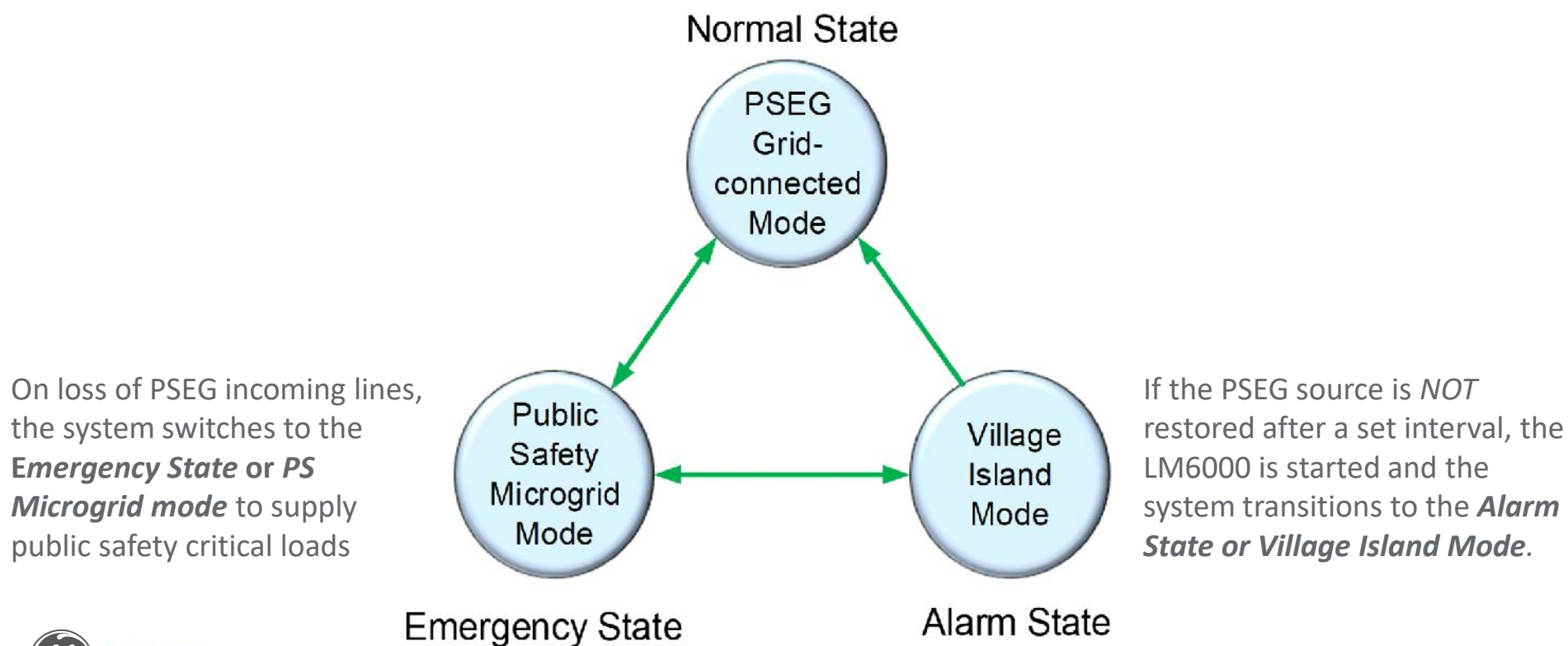


Electrical/Control Diagram



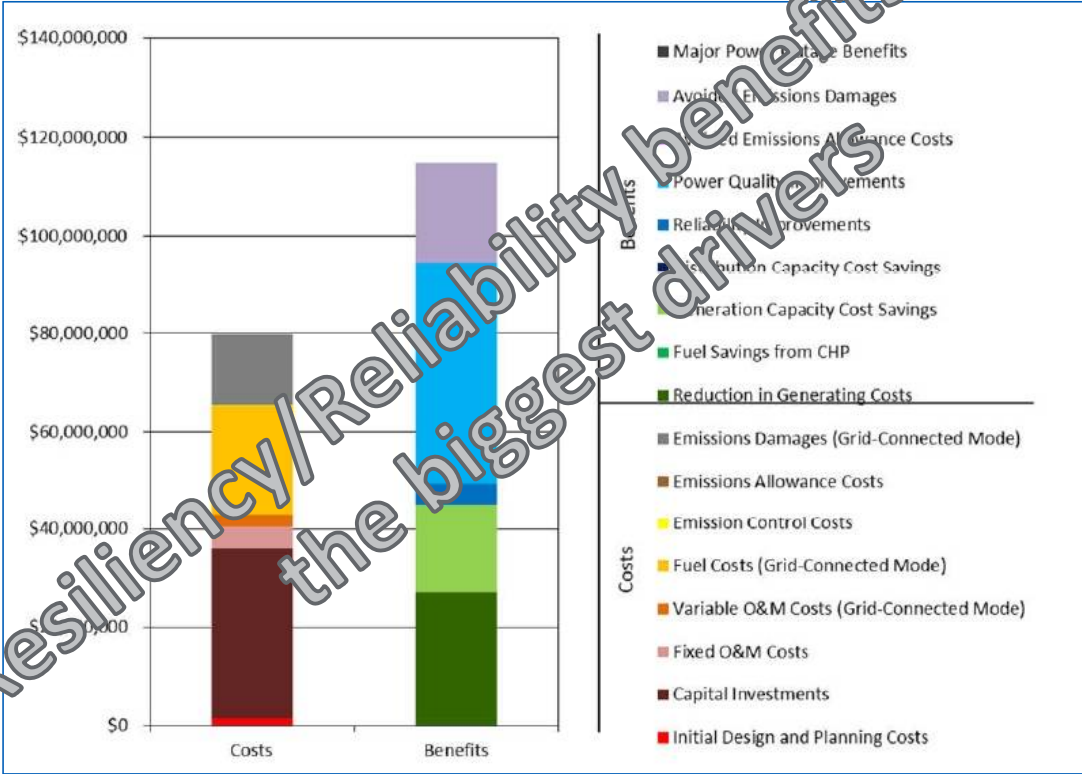
Microgrid Operating States

In the Normal State or PSEG Grid-connected mode Village loads are supplied by the utility. The Microgrid DER is not in service.



Summary of Benefit-Cost Analysis (Stage 1)

Cost or Benefit Category	Present Value Over 20 Years (2014\$)	Annualized Value (2014\$)
Total Benefits	\$114,872,626	\$9,669,228
Net Benefits	\$35,151,122	\$3,412,731
Benefit/Cost Ratio	1.44	
Internal Rate of Return	18.95%	



Key Take-Aways

General Observations

Microgrids bring together diverse engineering disciplines, including distributed generation, renewable resources, demand response, smart grid, and advanced control and communications and energy management systems

Key drivers are: customers looking for energy independence/surety; resiliency/reliability in US communities; and electrification of rural areas globally

The market is growing; expect to see a four-fold increase over the next five years

Microgrids can provide significant societal net benefits, as well as hard benefits/returns

Resiliency (soft) benefits drive positive BCA scores for many community microgrids

Microgrids with CHP and high thermal use loads can have positive BCA *even without* resiliency benefits

Lessons Learned

Analysis/output is only as good as the data/inputs – and data collection takes time!

Leveraging existing generation assets and distribution infrastructure could reduce investment needs, but adds to operational and commercial complexity

Utility support is critical to designing a reliable viable microgrid delivery system - some utilities are more supportive than others

Project value proposition improved significantly with participation of the microgrid assets in the utility DR programs and ISO capacity, energy, and ancillary markets

Societal benefits are applicable for public funding but do not necessarily move the meter for private investors

Operations and economics are significantly impacted by the regulatory environment and market conditions

Developing an economically sustainable commercial structure and business model can be challenging and extremely complex



Thank you!

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